



Technical Bulletin

Notes on Bonding of the 5000 series 3M Z-Axis Films

June, 1999

General Information

This publication is intended to aid the user in optimizing the performance of systems and assemblies using 5000 series of 3M Z-Axis Adhesive Films (ZAF).

Note: The information presented should be considered representative or typical and should not be used for specification purposes. The user is responsible for evaluating the film under actual conditions of use and with the substrates intended for the users application, to determine whether the film is suitable for a particular use and method of application.

Cleanliness

It is important that the surfaces of the flexible circuit (flex) and the Indium Tin Oxide (ITO)/Glass or printed circuit board (PCB) are free of contaminants and dust. If they become lightly contaminated in some manner (fingerprinted), we suggest using isopropyl alcohol and a lint free absorbent material. Do not overclean or scrub the circuits, as this may damage the circuit traces. The operator should use finger cots or gloves to prevent subsequent contamination of the circuits during the bonding process.

Note: Carefully read and follow manufacturer's directions for use and precautions when using cleaning solvents.

Application of film 5000 series ZAF to Substrate #1 (Pre-tacking)

Pre-tacking to the ITO/glass, PCB or flex substrate can be automated using equipment designed for this process or can be accomplished manually. The user should decide which substrate is to be pre-tacked based upon ease of handling during the second alignment and tacking step. When manually pre-tacking, the operator cuts a strip of 5000 series film to length (or slightly longer) and then lays the adhesive side down (liner side up) onto the ITO/glass or PCB substrate. The 5000 series of films are wound onto the reel such that the adhesive lays toward the center of the reel. A hot bar thermode or a soldering iron may be used to pre-tack these 3M films onto the substrate to hold it in place.

When using a hot bar, the pre-tacking conditions are: a temperature between 80 and 100°C with a pressure between 1 and 15 kg/cm² or less for 3 to 5 seconds. It is recommended that the user select the lowest pressure that can uniformly apply the 5000 series film to the substrate.

When using a soldering iron the temperature should be set such that a thermocouple placed between substrate #1 and the 5000 series film would measure a temperature less than 110°C in the area of the iron tip. The soldering tip is rolled gently down the length of the film to apply light pressure and heat.

Technical Bulletin

Notes on Bonding of the 5000 series 3M Z-Axis Films

Application of film 5000 series ZAF to Substrate #1 (Pre-tacking) *continued*

After pre-tacking the 5000 series film to the substrate, the film can be precisely cut to length and the liner removed. The assembly is now ready for lay-up of the second substrate.

Alignment of Substrate #2 and Tacking

Alignment is normally done using a camera and fixturing set up, or using a microscope for very fine pitch interconnection. Once the substrate #2 is properly aligned with substrate #1 of this assembly can be tacked with heat to temporarily hold the assembly together.

When using a hot bar, the tacking conditions are: a temperature between 80 and 100°C with a pressure between 1 and 15 kg/cm² or less for 3 to 5 seconds. It is recommended that the user select the lowest pressure that can join substrate #1 to substrate #2 with sufficient adhesion to move the sample to the bonding station without loss of alignment.

When using a soldering iron the temperature should be set such that a thermocouple placed between the substrates would measure a temperature less than 110°C in the area of the iron tip. The soldering tip should only be used to tack down both ends of the assembly, just enough to hold the assembly until bonding.

Tacking of the substrates together is not required if substrate #2 can be aligned properly in a fixture or in place under the thermode bonding head. The assembly is now ready for the bonding cycle.

Bonding Cycle

The final step in making a 5000 series ZAF interconnection is the high pressure/full temperature bonding cycle. The thermocompression (hot bar) bonder must be properly set-up for the particular assembly in question, following the guidelines found in **the 3M Z-Axis Bonding Film Thermocompression Bonding Set-Up Technical Bulletin:**

- Thermode must be aligned to the bonder stage and the assembly.
- Compliant layer must be used (0.2 to 0.3 mm thermally conductive silicone rubber or 75 micron polyimide film).
- Proper force calculated for the actual bond line area.
- Thermode temperature settings must be chosen to achieve proper bonding temperature (bondline temperature profile must be set-up and optimized). The thermode temperature will necessarily have to be set to a higher setpoint than the desired 180°C adhesive cure temperature in order to compensate for the thermal resistance of all the components in the assembly plus the heat losses into the compliant layer and bonder stage.

Technical Bulletin

Notes on Bonding of the 5000 series 3M Z-Axis Films

Bonding Cycle (continued)

The exact bond conditions will vary somewhat depending upon the parts to be joined. Figure 1 shows the contour map of proper bonding conditions for the 5000 series of Z-Axis films. A good starting place for the bonding cycle is:

Typical Bonding Conditions

Bonding Conditions	
Temperature*	170 - 190°C
Pressure	20 - 40 Kg/cm ²
Time	20 - 30 seconds

*Temperature measured in the adhesive. Thermode set points will be higher and will depend upon the substrate materials and bond equipment.

The temperature in the bond line should rise to 180°C within 3 to 8 seconds after the application of the thermode to the assembly. See Figures 2 and 3 for the idealized bond line temperature profile. Bondline temperature profiles must be set-up and optimized by the user for each different combination of substrates.

The tacked assembly is placed on the stage of the bonder and is aligned underneath the thermode. Fixturing is recommended to ensure proper orientation of the assembly with respect to the thermode.

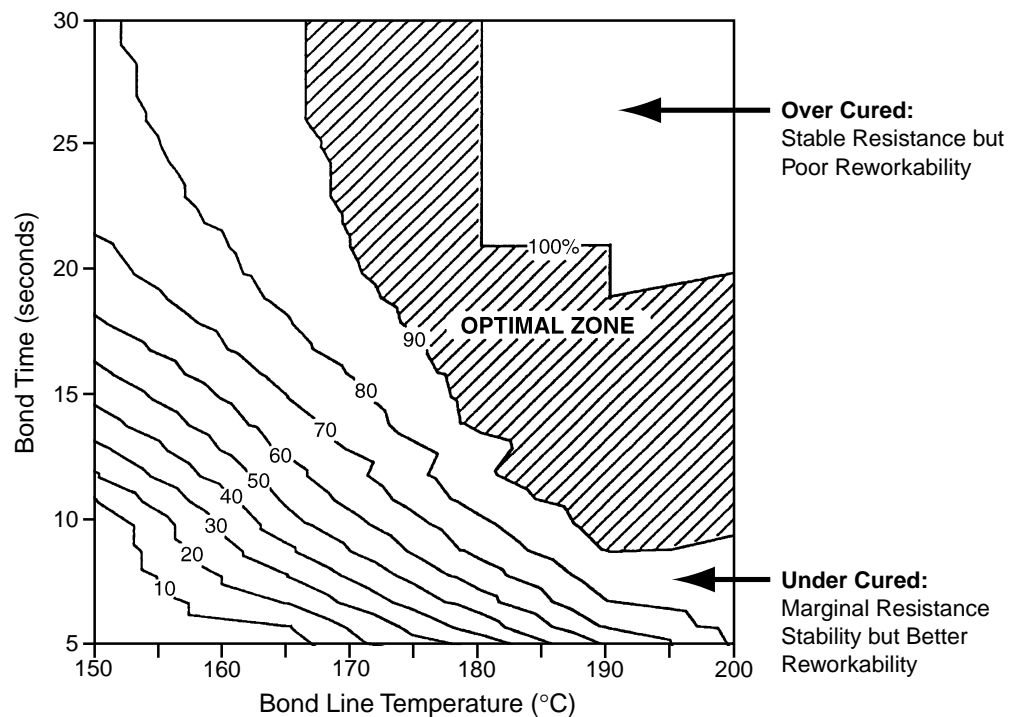


Figure 1: Cure conversion map for 5000 series of Z-Axis Films. Optimal curing gives good electrical results with the option to rework the bond. A good starting point is to bond at 180°C for 20 seconds. Pressure should be between 20 to 40 kg/cm².

Technical Bulletin

Notes on Bonding of the 5000 series 3M Z-Axis Films

Bonding Cycle *(continued)*

Visual Inspection

After letting the assembly cool, the bonded joint can be inspected under a microscope (5x to 50x). A good joint will exhibit the following characteristics:

- A fillet of adhesive should have formed along the top and bottom edge of the bond line, and this may be visible during inspection. It is desirable to not allow any adhesive to ooze around the top or bottom edge of the substrates along the bondline. The fillet enhances adhesion and good fillet formation is required for fine pitch electrical performance.
- There should be no damage to any substrate or the circuit lines. If such damage is observed the bonding pressure may be too high and should be checked.
- Occasionally voids are seen in the spaces between circuit lines which do not normally affect adhesion or electrical performance of the series 5000 ZAF.
- Contact your Technical Service representative if you have questions about the visual characteristics of the bonded parts.

Electrical Testing

After letting the assembly cool, the final bond may be tested electrically if the design permits. The bonded circuits should have the following characteristics:

- There should be no opens of interconnected traces and no shorts of adjacent traces (if so the bonding was not performed properly).
- The total measured resistance will be the sum of the trace resistance and the joint resistance. The joint resistance alone will be approximately 50 mΩ (flex to PCB) or 1 ohm (flex to ITO/glass) or less.
- Line-to-line resistance variation should be less than 10 mΩ (flex to PCB) or less than 0.8 ohm (flex to ITO/glass).

If the electrical properties are outside these guidelines it is possible the flex to substrate alignment was poor, or not enough pressure was applied, or the pressure was not uniformly applied.

Adhesion Testing

After letting the assembly cool, the final bond may be tested for adhesion strength. We recommend following test method IPC-2.4.9.1 when testing bond adhesion.

- See the data page for the specific adhesion level to expect for the various members of the 5000 series ZAF products. Adhesion will depend upon the exact nature of the substrates that have been bonded, and the design of the circuitry and solder mask in the bond region.
- Undercured bonds will show low adhesion and the flex can be easily peeled off the substrate. Properly cured bonds are quite strong and the flex circuit is difficult to remove by hand.
- Bonds created with improperly formed fillets will exhibit reduced adhesion.

Technical Bulletin

Notes on Bonding of the 5000 series 3M Z-Axis Films

Bonding Cycle (continued)

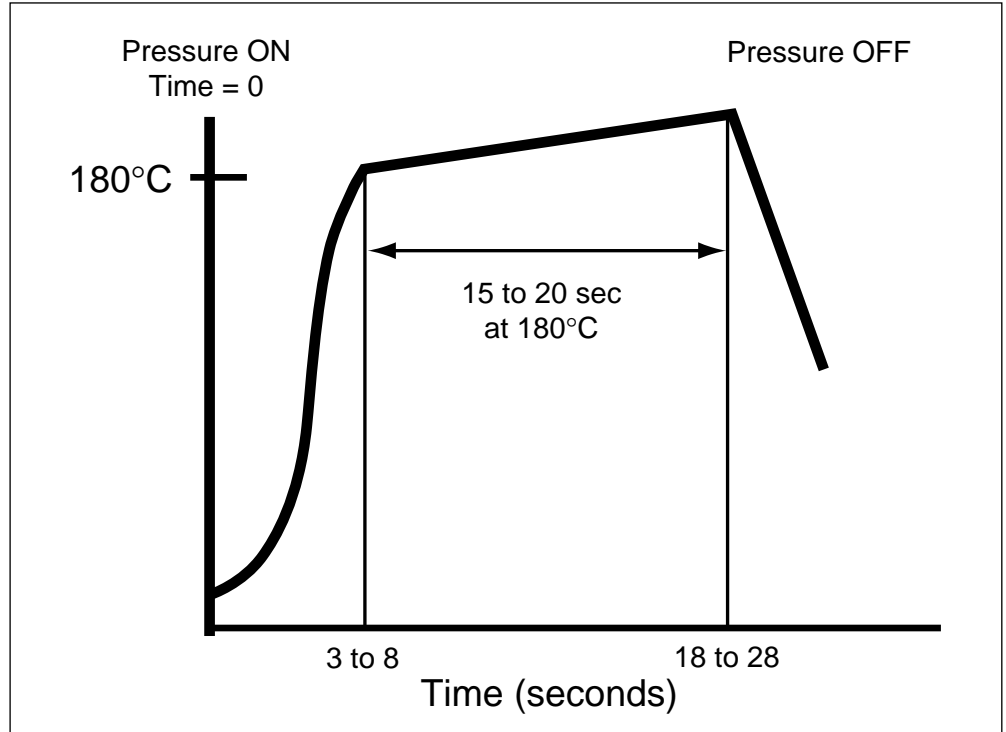


Figure 2. Idealized bond line temperature profile from a constant-temperature bonder.

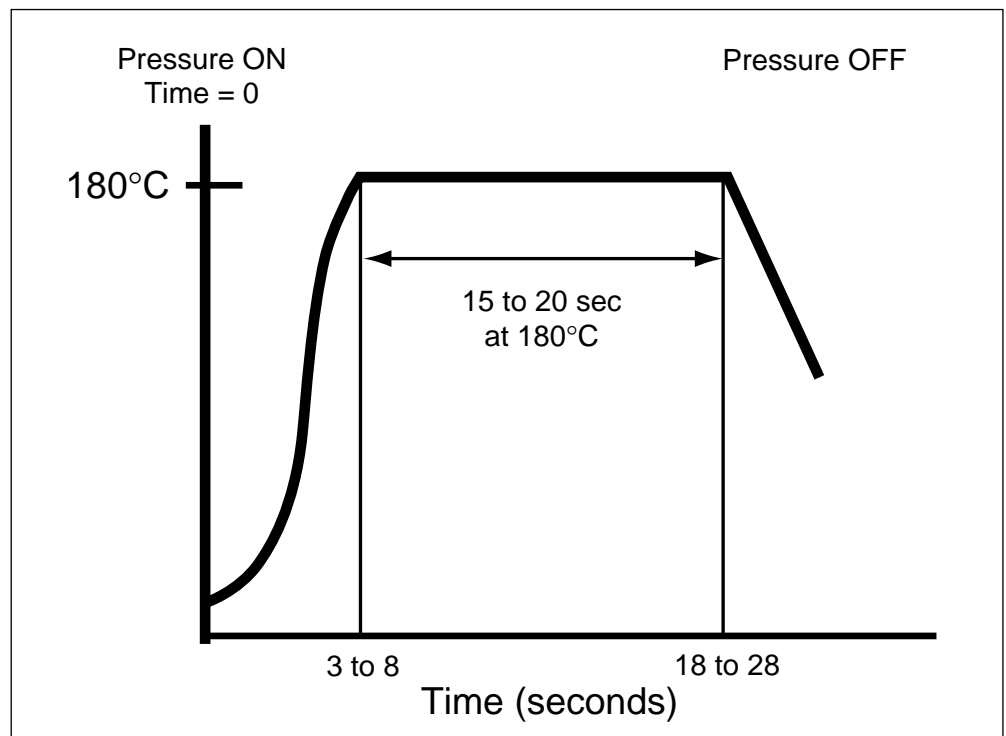


Figure 3. Idealized bond line temperature profile from a processor-controlled bonder.

Technical Bulletin

Notes on Bonding of the 5000 series 3M Z-Axis Films

Precautionary Information

Refer to product labels and Material Safety Data Sheet for safety and health information before using these products. Minimize skin contact during handling and use. Refer to product's Material Safety Data Sheet for protective glove recommendations.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free 1-800-362-3550. Address correspondence to: 3M Bonding Systems Division, 3M Center, Building 220-7E-01, St. Paul, MN 55144-1000. Our fax number is 651-733-9175. In Canada, phone: 1-800-364-3577. In Puerto Rico, phone: 1-809-750-3000. In Mexico, phone: 5-728-2180.

Important Notice

3M MAKES NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's method of application. Please remember that many factors can affect the use and performance of a 3M product in a particular application. The materials to be bonded with the product, the surface preparation of those materials, the product selected for use, the conditions in which the product is used, and the time and environmental conditions in which the product is expected to perform are among the many factors that can affect the use and performance of a 3M product. Given the variety of factors that can affect the use and performance of a 3M product, some of which are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

Limitation of Remedies and Liability

If the 3M product is proved to be defective, THE EXCLUSIVE REMEDY, AT 3M'S OPTION, SHALL BE TO REFUND THE PURCHASE PRICE OF OR TO REPAIR OR REPLACE THE DEFECTIVE 3M PRODUCT. 3M shall not otherwise be liable for loss or damages, whether direct, indirect, special, incidental, or consequential, regardless of the legal theory asserted, including, but not limited to, negligence, warranty, or strict liability.

ISO 9002

This Bonding Systems Division product was manufactured under a 3M quality system registered to ISO 9002 standards.



Bonding Systems Division

3M Center, Building 220-7E-01
St. Paul, MN 55144-1000



Recycled Paper
40% pre-consumer
10% post-consumer

Printed in U.S.A.
©3M 1999 70-0709-3735-7